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POTENTIAL OF SWAMP GAS AS A SUBSTITUTE FOR FOSSIL ENERGY IN THE FRAMEWORK OF ENVIRONMENTALLY CONSCIOUS ENERGY DIVERSIFICATION IN EAST JAVA PROVINCE

Nurkholis[a], Suyono Thamrin[b], Mohamad Sidik Boedoyo[c]

[a]Prodi Ketahanan Energi, Fakultas Manajemen Pertahanan, Universitas Pertahanan, 16810, **Indonesia**
[b]Prodi Ketahanan Energi, Fakultas Manajemen Pertahanan, Universitas Pertahanan, 16810, **Indonesia**
[c]Prodi Ketahanan Energi, Fakultas Manajemen Pertahanan, Universitas Pertahanan, 16810, **Indonesia**

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Abstract

This research aims to determine the distribution pattern of gas-containing sediments in East Java. The potential for biogenic gas in East Java can be determined by creating a shallow reflection seismic profile. The research locations are Sumenep Regency and Gresik Regency. The shallow reflection seismic profile of Sumenep Regency shows that sequences A and B are penetrated by mud diapirs. New black clay was discovered in the Holocene–Pleistocene Pamekasan Formation. In Sumenep, the formation of biogenic gas and deposition of sediment as source rock and reservoir occurred over a short period of time so that gas production was insufficient. The biogenic gas content near the surface in black clay is low, so there is no potential for further exploration. The minimal potential for biogenic gas near the surface in the Sumenep Basin is caused by tectonic processes, stratigraphic conditions (estuary systems) and structures (small faults and mud diapirs) which influence the migration and accumulation pathways of biogenic gas. In Gresik Regency, the potential distribution of sediment containing biogenic gas can only be observed laterally and is very difficult to observe vertically. The gas deposits are estimated to be in the C order and are evenly distributed

Keywords: ***Shallow Biogenic Gas; Energy; Environmentally Friendly Energy; Estuaries; Mud Diapir; Black Clay.***

1. Introduction

Sedimentary basins are parts of the earth's crust that can act as a place for the accumulation of relatively thicker sediment layers than their surroundings, where the accumulation of sedimentary rocks can act as a place for the formation and accumulation of oil and natural gas. The North East Java Basin was formed as a back arc basin. The North East Java Basin covers an area of 50,000 km2 covering the land east of Central Java, East Java, offshore around the North Java Sea to the Madura Strait. The shallow gas produced will be very useful as an alternative energy in meeting household needs.

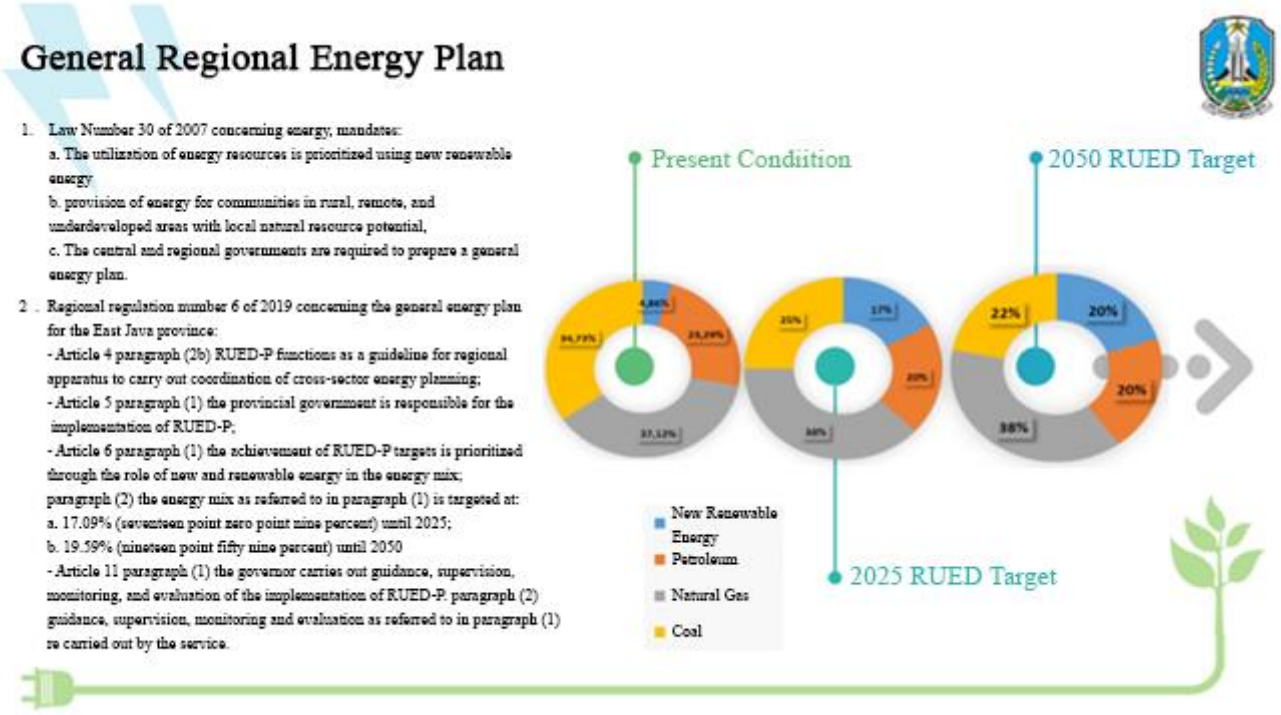
The formation of shallow gas can occur biogenically or thermogenically. Methane produced by methanogenic bacteria is known as biogenic gas, which is produced by animals and bacteria at low temperatures. It is exclusively found in current sediments and is created by organic activity. Thermogenic, on the other hand, is created by high-temperature tectonic activity and is usually found very far below the surface; although it appears at the depth of cracks, its penetration process occurs through cracks (Faturachman et al., 2016).

According to Rice (1993), there are two possibilities for the formation of biogenic gas: first, biogenic gas can form immediately after the source and reservoir rocks are deposited, known as early formation. Second, it can form later, after the rocks are formed, called late formation. Formation at the beginning of the process provides plenty of time for the gas produced to move and accumulate. However, the late formation, which was formed longer than the source and reservoir rocks, prevents gas from migrating and accumulating for a longer period of time, thus reducing the accumulation of gas in the reservoir rock. Shallow biogenic gas can accumulate in the same stratigraphic unit between the source rock and the reservoir rock. The relationship between biogenic gas formation and accumulation is very close in space and time scales, so that as a consequence a short migration path will be formed.

Meanwhile, according to Schoell (1988), marsh gas is a biogenic gas whose formation process is divided into three main processes, namely anaerobic bacterial fermentation, acetate bacterial fermentation in sediment layers rich

in organic matter, and the process of reducing CO2 by bacteria. Biogenic gas has the characteristics of being odorless, low to medium pressure and has localized dimensions (isolated). The manifestation of marsh gas will be clearly visible on the land or rice fields of residents who are watery which emit gas bubbles that appear on the surface. In some cases, marsh gas sprays on residents' water drill holes that accidentally penetrate the marsh gas pocket. We have often witnessed this incident lately, marsh gas comes out with water slightly mixed with sand-sized material with a spray height that can reach 20 meters.

East Java has oil and gas potential along the North Coast of East Java and Madura, but the results of oil and gas resource management are little enjoyed by the community in the region, in addition to the community in oil and gas producing areas do not necessarily enjoy oil and gas facilities because the distribution of infrastructure is uneven, so it is very prone to social unrest in the region. The East Java Government is also mandated to increase the Energy Mix Target from New and Renewable Energy in Regional Regulation No. 6 of 2019 concerning the General Energy Plan for the East Java Province for 2025-2050) through increasing the use of gas for industry and households, in addition to the use of renewable energy generators.



Picture1. Regional Energy General Plan

Therefore, the utilization of Biogenic Shallow Gas Methane (BSGm) potential for rural communities is a solution, increasing the added value of BSGm, neutralizing social conflicts in oil and gas producing areas, increasing the East Java Energy Mix Target and improving community welfare. The location of the research area is in East Java Province. The purpose of this study is to determine the potential distribution pattern of gas-containing sediment (gas charged sediment) and the role of geological settings on the migration and accumulation of biogenic gas in East Java Province.

2. Research methods

2.1 Literature review

Before conducting direct observation activities in the field, studies on matters related to the research need to be conducted. This is done to get a general picture of geological conditions, population conditions and environmental conditions. This study is conducted by searching for literature or information both in various communication media related to the research area. Some sources used as references in this pre-field investigation include:

- Regional Geological Map
- Topographic Map of Indonesia
- Documents from the Central Bureau of Statistics
- Satellite Imagery
- National DEM Image

2.2 Data Collection Method

A. Geological Mapping

Geological Mapping is an activity to describe geological information in detail with a scale that adjusts the results of review survey activities or prospecting activities. This geological mapping is an activity based on actual data in the field, not an enlargement of the Regional Geological Map 1:100,000. Geological information taken in the field includes rock units, geological structures, and stratigraphic columns.

Geological mapping is done by tracing the area by creating observation paths and observation location points. Field exploration is done while creating observation locations (LP). Data taken at each observation station includes local morphological data, lithology distribution patterns, and geological structure observations. In addition to creating observation points, geological observation paths are also made to determine access that can be passed by observers and the distribution of lithology. In geological mapping, rock samples are also taken for rock physics (geotech), rock chemistry (geochemistry), and petrographic analysis using the grab sampling method. Sampling is carried out based on genetic differences in the form of differences in lithology characteristics at the research location.

B. Topographic Mapping

Topographic mapping is done in the form of taking elevation data to adjust topographic maps using drone mapping. The drone used is the DJI Mavic 2 Pro using the drone deploy support application. Then the orthophoto data is processed using Agisoft software, PCI Geomatic into DEM data and contour smoothing (flattening), then laid out in Arcmap software. The resulting map is a topographic map.

C. Geochemical Survey

Geochemical surveys are conducted by taking rock samples based on the genetic differences of rocks at the exploration site. Geochemical surveys are conducted by taking hand spaciment-sized rock samples with the grab sampling method based on genetic differences in the field and then tested in the laboratory using the XRF (X-Ray Fluorescence) method. In geochemical testing, several compounds are seen, including Na2O, MgO, Al2O3, SiO2, K2O, CaO, K2O, TiO2, Cr2O3, FeO, SO3, SrO, P2O3, Cl and Fe2O3. For MC and SG using the gravimetric method.

D. Drilling

The exploration drilling method in this activity is the full coring method. The full coring method is an open drilling method by drilling to the planned depth and taking all core samples at each meter of the drill bar. Samples are taken for XRF analysis based on genetic differences at the exploration location. For XRF analysis, samples are taken every meter with a break every half meter if there is a genetic difference.

2.3 Laboratory Investigation

A. Chemical Analysis

Chemical analysis is carried out using the XRF method to see the elements and compounds present in the samples that have been taken. The rock samples taken and tested are raw materials in the sense that the material has not been processed and is still mixed with other elements and compounds. In chemical testing, several compounds that need to be seen include Na2O, MgO, Al2O3, SiO2, K2O, CaO, K2O, TiO2, Cr2O3, FeO, SO3, SrO, P2O3, Cl and Fe2O3. For MC and SG using the gravimetric method.

B. Physics Analysis

Physical analysis is carried out using the rock physical test method to see the physical properties of the rock such as water content, wet weight, dry weight and uniaxial value. The rock samples taken and tested are raw materials in the sense that the material has not been processed and is still mixed with other elements and compounds. In physical testing, several physical properties that need to be seen include water content, wet weight, dry weight and uniaxial value. Testing is carried out according to SNI which refers to ASTM.

2.4 Data processing

A. Geological Data Processing

Geological data processing is done digitally using Microsoft Excel, arcGIS, Global Mapper, 3D Mine and Corel Draw software. The results of geological data processing are in the form of geomorphological maps, geological track maps, geological maps, topographic maps, alteration maps, and petrographic analysis.

C. Geochemical and Geotechnical Data Processing

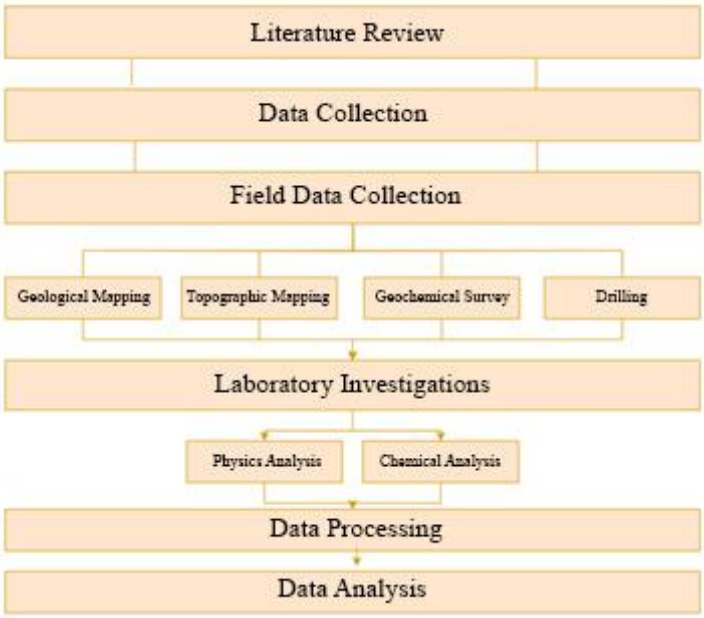
Geochemical data processing is processed through Microsoft Excel software, and 3D Mine digitally. Geotechnical data is processed using Slide 6.0 software.

2.5 Data analysis

From the results of the data processing, the problem can be discussed for its solution. The results of the analysis obtained shallow reflection seismic profiles, swamp gas potential, and geological settings.

2.6 Conclusion and Suggestions

In the final stage of this research, all important matters related to the potential of swamp gas as a substitute for fossil energy in the context of environmentally friendly energy diversification in East Java were concluded.



Picture2.Research Flow Chart

3. Results and Discussion

3.1. Condition of East Java Province

The territory of East Java Province consists of land area of 47,130.15 km2 and sea area of 110,764.28 km2 located at coordinates 1110 0' BT - 1140 4' BT and 70 12' LS - 8 0 48' LS. East Java is bordered by the Java Sea to the north, the Indonesian Ocean to the south, the Bali Strait/Bali Province to the east, and Central Java Province to the west. Based on its territory and administrative areas, East Java is divided into 29 districts and 9 cities.

3.2. Regional Geology

The stratigraphy of the research area from the oldest to the youngest rock layers is summarized in the following table (Situmorang, RL, drr., 1993):

*Table 1.*Regional Geology

No.	Regional Geology	Explanation
1.	Tawun Formation	Consisting of limestone, marl, argillaceous limestone, with inserts of orbitoid limestone and mudstone. The depositional environment of the Tawun Formation is a protected shallow shelf (inner sublittoral zone). The Tawun Formation is the main oil reservoir in the Rembang Zone. Based on the fossil content, the Tawun Formation is estimated to be of Early Upper Miocene to Middle Miocene age.
2.	Ngrayong Formation	Characterized by fine-grained - coarse quartz sandstone, alternating with carbonate shale, shale and claystone. Bioclastic limestone inserts containing Orbitoid fossils are also found upwards. Ngrayong Sand was deposited in a regressive phase from a shallow marine environment in the Middle Miocene, overlapping conformably above the Tawun Formation. The thickness of this formation is about 600 meters.
3.	Feather Formation	The Bulu Formation consists of alternating limestone and calcarenite, sometimes found with mudstone inserts. This formation was deposited in a

		shallow marine environment, its age is upper Middle Miocene with a thickness of about 600 meters.
4.	Pasean Formation	Alternation of sandy marl with clayey limestone, sandy limestone and oolite limestone, well-layered, containing many foraminifera (Sugiharto & Jusfarida, 2021). The depositional environment is shallow marine zone (inner sublittoral). The age is late Miocene
5.	Madura Formation	Pliocene age. Consists of reef limestone, dolomitic limestone, sandy limestone and marl. The depositional environment is litoral-sublitoral, open, calm and warm.
6.	Pamekasan Formation	Has a Littoral-Fluviatile depositional environment. Pleistocene age. Consists of mudstone, quartz sandstone, conglomerate and limestone.
7.	Alluvium	Holocene age. Consists of river, beach and swamp deposits consisting of sand, clay, mud, gravel and pebbles.

Source: (Situmorang, RL, drr., 1993)

3.3. Energy Condition of East Java Province

The availability of energy and its infrastructure plays a vital role in the development of a region to improve the regional economy. Therefore, energy supply has a major impact on other sectors. The growth of East Java's energy needs is related to economic growth and social/population growth.

4. Conclusion

The shallow reflection seismic profile of Sumenep Regency shows that sequences A and B are penetrated by mud diapirs. Black clay was only found in the Holocene-Pleistocene Pamekasan Formation. In Sumenep, the formation of biogenic gas and sediment deposition as source rock and reservoir occurred in a short time so that gas production was insufficient. The content of biogenic gas near the surface in black clay is low, so there is no potential for further exploration. The minimal potential for biogenic gas near the surface in the Sumenep Basin is caused by tectonic processes, stratigraphic conditions (estuarine systems) and structures (small faults and mud diapirs) that affect the migration path and accumulation of biogenic gas. In Gresik Regency, the distribution of potential deposits containing biogenic gas can only be observed laterally and is very difficult to observe vertically. The gas deposits are estimated to be in the C order and are evenly distributed. Based on this analysis, the potential for the energy sector was obtained, especially in East Java. The benefits that can be taken include providing a solution for rural communities, increasing the added value of BSGm, neutralizing social conflicts in oil and gas producing areas, increasing the East Java Energy Mix Target and improving community welfare.

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